July 22, 1995

Annual Report

**Jupiter Thermospheric General Circulation Model
NASA Grant NAGW-3624/SwRI Project #15-5565**

Prepared by J. H. Waite, Jr., Southwest Research Institute

This report outlines the progress made during the second year of funding under NASA Grant NAGW-3624 on the development of a Jupiter Thermospheric General Circulation Model (JTGCM). When completed at the end of the third year of funding, the prototype JTGCM will incorporate Jovian thermospheric and ionospheric physical processes and chemistry within the computational framework of the NCAR TGCM. (The thermospheric/ionospheric physics and chemistry for the JTGCM will be taken from the PI's upgraded 1-D theoretical model of Jupiter's thermosphere and ionosphere. The basic 1-D thermosphere-ionosphere model is described by *Waite et al.* [1983]. Detailed descriptions of the original NCAR TGCM are given by *Dickinson et al.* [1981;1984], and the modifications of the code and its application to Venus and Mars are described by *Bougher et al.* [1988a,b]. A coupled thermosphere-ionosphere model for the Earth is reviewed by *Roble et al.* [1988].)

Work during the second year has focused on modification of the NCAR TGCM and the upgrading of the 1-D Jovian thermosphere/ionosphere model (particularly through the analysis of HST and ROSAT images to determine the auroral input function). These activities are discussed briefly below. Reprints of the appropriate publications (identified in the text with an asterisk) are included as Appendix A.

TCGM Modification. A critically important modification of the NCAR TGCM undertaken and completed during the second year has been the redefinition of time within the model to permit any rotational period to be accommodated. A Jupiter sol consisting of 24 Jupiter hours was adopted for use in the control code. This is equivalent to redefining the Jupiter second to conform to a 24-hour day like that of the Earth. However, for dynamics the time step is multiplied by the ratio of the number of "standard" seconds in a Jupiter sol (35550) to the number for the Earth day (86400). This transformation enables the JTGCM model runs to be handled with the same bookkeeping scheme (input/output histories) as used for the terrestrial TGCM. Moreover, it enables the TGCM interpolation routines to correctly shift local time through planetographic longitude during the course of a Jupiter sol.

A further modification of the code made during the second year has been the specification of the fundamental Jovian planetary parameters—e. g., radius, gravity, obliquity, mean heliocentric distance, etc. (coincident magnetic and rotational poles are assumed).

Finally, the major neutral species (H, H_2, and He) have been incorporated into the code. The diffusion equations for these species have not yet been tested, however. This will take place during the final development and testing of the prototype code during the third year, as will the incorporation into the code of the major ions (H_3^+ and H^+, with H_2^+ as a diagnostic) (according to the 1-D model of *Waite et al.* [1983], as upgraded) and IR-active hydrocarbon species (CH_4, C_2H_2, C_2H_6) (according the hydrocarbon models of *Gladstone et al.* [1995]).

Determination of Auroral Input Function. JTGCM input functions will include both aurora-driven and EUV-driven heating and neutral and ion production. The code will account for

EUV forcing by assuming a constant (globally averaged) set of EUV production rate profiles for H, H^+, and H_2^+ production and heating. Auroral energy inputs as a function of column depth in H_2 are generated with a two-stream electron transport code [Waite et al., 1983] and are empirically fit as a function of electron energy. (The relative role of ion versus electron precipitation will be neglected in the prototype, but this is not a major limitation since Horányi et al. [1988] have shown that the only significant aeronomical difference is a change in relative efficiency.)

Because auroral forcing dominates the energy input into the Jovian thermosphere, it is extremely important that auroral energy input be accurately modeled in order to produce a quantitative physical description. This has been the second major focus of our second-year work. Our concept is to use HST ultraviolet data to determine the morphology and vertical structure of the precipitating particle input function for the model. Model outputs (e. g., predicted IR emission patterns) can then be compared with observations of auroral emissions at various wavelengths to verify the model. (Auroral observations are our principal source of data required for JTGCM verification.) For example, model output will be compared with observed infrared H_3^+ and CH_4 emissions to verify modeled thermal structure, while comparison with observed ultraviolet Lyman alpha line profiles and H_2 spectral data will permit verification of predicted wind directions and temperatures. (The use of H_3^+ images as a diagnostic of Jovian auroral processes has been discussed by the PI in a recent IUGG quadrennial review [Nagy et al., 1995].* The use of observations from ground-based and Earth-orbiting observatories and from Galileo to complete the JTGCM verification process is described in the proposal recently submitted by the PI in response to NRA 95-OSS-05.)

Our second-year work on the auroral input function has concentrated in particular on the specification of Jovian auroral morphology. We have been working with Denis Grodent, a student of Professor Jean Claude Gérard from the University of Liége, on the analysis of HST data, the initial results of which were reported late last year in Science [Gérard et al., 1994].* In our follow-on work during this second year, we have developed a simulation code of the 3-D ultraviolet radiative transfer in the auroral zone and used the code to simulate both HST Faint Object Camera and Wide Field Planetary Camera 2 images of the Jovian aurora. In parallel, we have used our 1-D precipitation model to reconstruct the vertical input function required by the simulation code. This allows us to use the HST images to produce a 3-D specification of the particle input function that can be empirically inserted into the JTGCM as an input function. A preliminary report of this work in progress was presented by Jean Claude Gérard at the Boulder IUGG meeting in July.

The analysis and modeling of auroral x-ray data have also played a central role in the work performed during the second year of this grant. We have completed a follow-on x-ray modeling study of ion precipitation [Cravens et al., 1995]* that provides a quantitative assessment of the ROSAT observations analyzed by Waite et al. [1994] as part of the first-year work funded by this grant. Additionally, auroral x-ray data acquired shortly before and during the SL9 impact with Jupiter contain an intriguing hint of a possible dependence of auroral emission intensity on the phase of Io. (Preliminary analysis of IUE data appears to suggest a similar Io-phase-dependence in the case of the UV aurora as well.) Further analysis of the x-ray and UV observations will be undertaken to verify this possible link between auroral emission intensity and the longitude of Io. If confirmed, this dependence would have implications for auroral morphology that would need to be accounted for in the modeling of auroral forcing of the thermosphere. The initial analysis of

the x-ray data from the SL9 impact period, which was partially funded by this grant, has been reported in *Science* by *Waite et al.* [1995].*

Finally, as noted in our original proposal, the JTGCM can be adapted to model the thermosphere of Saturn. As a prelude to the eventual adaptation of the code to Saturn, we have begun a study of Saturn's aurora using HST data, again in collaboration with Jean Claude Gérard. The analysis of these data was partially supported by this grant and is reported by *Gérard et al.* [1995].*

References

Bougher, S. W., R. E. Dickinson, E. C. Ridley, and R. G. Roble, Venus mesosphere and thermosphere III. Three-dimensional general circulation model with coupled dynamics and composition, *Icarus*, *73*, 545, 1988a.

Bougher, S. W., R. E. Dickinson, E. C. Ridley, and R. G. Roble, Mars thermospheric general circulation model: calculations for the arrival of Phobos at Mars, *Geophys. Res. Lett.*, *15*, 1511, 1988b.

Clarke, J. T., L. Ben Jaffel, A. Vidal-Major, G. R. Gladstone, J. H. Waite, Jr., R. Prangé, J. C. Gérard, J. Ajello, and G. James, Hubble Space Telescope high-resolution spectrograph H_2 rotational spectra of Jupiter's aurora, *Ap. J.*, *L73*, 430, 1994.

Cravens, T. E., Vibrationally excited molecular hydrogen in the upper atmosphere of Jupiter, *J. Geophys. Res.*, *92*, 11083, 1987.

*Cravens, T. E., E. Howell, J. H. Waite, Jr., and G. R. Gladstone, Auroral oxygen precipitation at Jupiter, *J. Geophys. Res.*, in press, 1995.

Dickinson, R. E., E. C. Ridley, and R. G. Roble, A three-dimensional general circulation model of the thermosphere, *J. Geophys. Res.*, *86*, 1499, 1981.

Dickinson, R. E., E. C. Ridley, and R. G. Roble, Thermospheric general circulation with coupled dynamics and composition, *J. Atmos. Sci.*, *41*, 205, 1984.

Drossart, P., B. Bézard, S. K. Atreya, J. Bishop, J. H. Waite, Jr., and D. Boice Thermal profiles in the auroral regions of Jupiter, *J. Geophys. Res.*, *98*, 18803, 1993.

*Gérard, J. C., D. Grodent, R. Prangé, J. H. Waite, G. R. Gladstone, V. Dols, F. Paresce, A. Storrs, L. Ben Jaffel, and K. A. Franke, A remarkable auroral event on Jupiter observed in the ultraviolet with the Hubble Space Telescope, *Science*, *266*, 1675, 1994.

*Gérard, J. C., V. Dols, D. Grodent, J. H. Waite, G. R. Gladstone, R. Prangé, Simultaneous observations of the Saturnian north ultraviolet aurora and dark polar region with the HST-FOC, *Geophys. Res. Lett.*, in press, 1995.

Gladstone, G. R., M. Allen, and Y. L. Yung, Hydrocarbon photochemistry in the upper atmosphere of Jupiter, *Icarus*, submitted, 1995.

Horányi, M., T. E. Cravens, and J. H. Waite, Jr., The precipitation of energetic heavy ions into the upper atmosphere of Jupiter, *J. Geophys. Res.*, *93*, 7251, 1988.

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Roble, R. G., E. C. Ridley, A. D. Richmond, and R. E. Dickinson, A coupled thermosphere-ionosphere general circulation model, *Geophys. Res. Lett.*, *15*, 1325, 1988.

Trafton, L. M., J. C. Gérard, G. Munhoven, and J. H. Waite, Jr., High-resolution spectra of Jupiter's northern auroral ultraviolet emissions with the Hubble Space Telescope, *Ap. J.*, *421*, 816, 1994.

Waite, J. H., Jr., et al., Electron precipitation and related aeronomy of the Jovian thermosphere and ionosphere, *J. Geophys. Res.*, *88*, 6143, 1983.

Waite, J. H., et al., ROSAT observations of the Jupiter aurora, *J. Geophys. Res.*, *99*, 14799, 1994.

*Waite, J. H., Jr., et al., ROSAT observations of x-ray emissions from Jupiter during the impact of comet Shoemaker-Levy 9, *Science*, *268*, 1598, 1995.

Statement of Work for NASA Grant NAGW-3624: Third-Year Funding
(SwRI Project 15-5565)

During the third year of funding under Planetary Atmospheres grant NAGW-3624 (FY95), the NCAR TGCM, as adapted for Jupiter during the first two years of funding, and the PI's upgraded 1-D model of Jovian thermospheric/ionospheric chemistry and energetics will be integrated to create a prototype Jupiter Thermospheric General Circulation Model (JTGCM). The prototype code will then be tested and verified. T, 3-component winds, and major neutrals and ions will be calculated for a symmetric auroral forcing and a globally averaged EUV forcing. These calculations will provide a first-order assessment of the influence of the aurorally driven wind system on the global distribution of H and He and temperature and will make it possible to study the "gross" features of the Jupiter thermospheric circulation and to compare the resulting density and temperature distributions with available data. The code will permit assessment of the importance of Coriolis torques and of the character and magnitude of the global effects of auroral forcing.

Specific tasks to be completed during the third year for final development/testing of the prototype JTGCM are listed below.

(1) Test the major species diffusion equations for H and He, including major sources and sinks for H. Previous TIGCM framework will be used.

(2) Set up the major species diffusion equations for H^+ and H_3^+, including major sources and sinks, ambipolar diffusion, etc. The Waite 1-D model framework will be used. Neutral winds will be used for advection at this time. H_2^+ will be calculated as the only photochemical species.

(3) Extract production rates from the Waite 1-D code for parameterization within the Jupiter TGCM. These include the production of H^+, H_2^+, and H. Both auroral (symmetric in SIII longitude) and EUV (global average) rates are required.

(4) Similarly, extract the energy deposition rates from the Waite 1-D code for the auroral (symmetric in SIII longitude) source. Parameterize this rate in the Jupiter TGCM as a function of the column of H_2.

(5) Adapt a hydrocarbon cooling scheme from *Drossart et al.* [1993] for C_2H_2, CH_4, and C_2H_6 cool-to-space emission within the Jupiter TGCM.

(6) Prescribe hydrocarbon species in the Jupiter TGCM below 1-μbar (C_2H_2, CH_4, and C_2H_6) from *Gladstone et al.* [1995]. These will be used in (a) hydrocarbon cooling calculations and (b) neutral/ion species chemistry.

(7) Complete simulation analysis of HST images to produce a 3-D description of the auroral particle input function.

(8) Conduct SIII-symmetric auroral forcing cases. Examine the zonally averaged output to study the meridional distribution of H and He and temperatures. Unfold the relative roles of meridional transport and Jupiter rotation in maintaining these distributions. Compare with available data.

(9) Note model/data discrepancies in this initial study of gross features of the Jupiter upper atmosphere. Identify the modifications to fields anticipated by future Jupiter TGCM improvements (e.g., H_2 vibrational chemistry, photochemical ions, ion drag and Joule heating, etc.).

(10) Continue investigation of possible Io-phase dependence of auroral emissions [*Waite et al.*, 1995] as preparation for the incorporation of more realistic, asymmetric auroral forcing in the JTGCM.

References

Drossart, P., B. Bézard, S. K. Atreya, J. Bishop, J. H. Waite, Jr., and D. Boice Thermal profiles in the auroral regions of Jupiter, *J. Geophys. Res.*, *98*, 18803, 1993.
Gladstone, G. R., M. Allen, and Y. L. Yung, Hydrocarbon photochemistry in the upper atmosphere of Jupiter, *Icarus*, submitted, 1995.
Waite, J. H., Jr., et al., ROSAT observations of x-ray emissions from Jupiter during the impact of comet Shoemaker-Levy 9, *Science*, *268*, 1598, 1995.

A Proposal For

ENERGETICS & DYNAMICS OF JUPITER
UPPER ATMOSPHERE - 3RD YEAR

Solicitation Number   NRA OSSA-92-3

SwRI Proposal Number   15-13046D

July 20, 1995

Prepared For:

NASA HEADQUARTERS

Prepared By:

Southwest Research Institute
6220 Culebra Road
San Antonio, Texas 78238-5166

Contract Administrator: G. R. Krisch, (210) 522-2236
Director of Contracts: Robert E. Chatten, (210) 522-2235
Technical Point of Contact: J. Hunter Waite, (210) 522-3493

Southwest Research Institute
Proposal No.   15-13046D
Solicitation No. NRA OSSA-92-3

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Southwest Research Institute
GOVERNMENT GRANT PROPOSAL

SwRI Proposal No. 15-13046D
Solicitation No. NRA OSSA-92-3

Cost and Pricing Data

It is desired that a grant be provided, with cost determination in accordance with the appropriate Procurement Regulations. The total estimated cost to perform the proposed program is $79,948.00

Manpower allocations are engineering estimates based upon a detailed evaluation of program requirements. In consultation with key technical personnel to be assigned responsibility for accomplishment of this project, engineering estimates of man hours required were obtained. The man hours thereby identified with specific skill levels were then grouped into appropriate labor classifications as shown on Attachment A.

In accordance with the method acceptable to DCAA the labor rates used in the cost estimate are weighted average rates for each labor category based on utilization. An allowance has been included for annual salary increase. The annual salary increases are based upon a review of current and anticipated future economic conditions.

In accordance with the current approved procedures, Southwest Research has prepared this proposal based upon applicable Government-approved provisional indirect rates.

SwRI's CAS Disclosure Statement was submitted to and determined to be adequate by DCMAO, San Antonio.

Contractual Information

Intended place of performance is Southwest Research Institute, 6220 Culebra Road, San Antonio, Texas.

This proposal shall remain in effect no longer than sixty (60) days from date of presentation. This proposal constitutes an offer and, if accepted by a Notice of Award placed in the mail addressed to SwRI, will form a binding contract on the terms covered by this proposal. It is agreed that any such Notice of Award will be replaced at a later date by a definitive contract bearing the same date as the Notice of Award and containing the details of the agreement between the parties.

Personnel for any negotiations required on this procurement may be contacted as follows:

Contractual: Mr. G. R. Krisch, Contract Administrator, Contracts, 210/522-2236;
Mr. Robert E. Chatten, Director, Contracts, 210/522-2235.

Technical: Dr. J. Hunter Waite, Jr., Institute Scientist, Instrumentation and Space Research Division, 210/522-3493;
Dr. James L. Burch, Vice President, Instrumentation and Space Research Division.

It is requested that copies of any correspondence evaluating this proposal be submitted to the contractual representative to improve our responsiveness to your requirements.

The Defense Logistics Agency, Defense Contract Management Area Operations, 615 East Houston Street, San Antonio, Texas 78294, 210/229-6711, has been assigned responsibility for administration of Department of Defense contracts. The agency having cost cognizance on all Government Contracts awarded this contractor is the Defense Contract Audit Agency, San Antonio, 6220 Culebra Road, San Antonio, Texas 78238, 210/522-2004.

Contractor's current financial statements are filed quarterly with the Defense Contract Audit Agency and the Defense Logistics Agency, who is also responsible for the negotiation of the overhead rates. The accounting policy and procedures of SwRI are reviewed and approved on a current basis as acceptable for Government cost-type contracts by the Defense Contract Management Area Operations of the Defense Logistics Agency.

Payment

It is requested that the clause entitled "Electronic Funds Transfer Payment Methods" (Apr 1989) of FAR 52.232-28 be included in any resulting contract as prescribed in FAR 32.908(d). Government payment clause FAR 52.216-7 "Allowable Cost and Payment" is requested.

Payment shall be addressed as follows:

Southwest Research Institute
P. O. Box 841671
Dallas, Texas 75284-1671

Contingent Fee Statement

Bidder represents: (a) that he has not employed or retained any company or person (other than a full-time, bona fide employee working solely for the bidder) to solicit or secure this contract, and (b) that he has not paid or agreed to pay to any company or person (other than full-time, bona fide employee working solely for the bidder) any fee, commission, percentage or brokerage fee, contingent upon or resulting from the award of this contract, and agrees to furnish information relating to (a) and (b) above as requested by the Contracting Officer. (For interpretation of the representation, including the term "bona fide employee," see Code of Federal Regulations, Title 41, Subpart 1-1.5.)

SOUTHWEST RESEARCH INSTITUTE

By: Robert E. Chaften
Title: Director, Contracts
Date: July 20, 1995

2

Exhibit 1

Budget Summary

From _____8/1/95_____ **to** ___7/31/96_____

NASA USE ONLY

	A	B	C
1. Direct Labor (salaries, wages, and fringe benefits)	24,298		
2. Other Direct Costs:			
a. Subcontracts	23,285		
b. Consultants			
c. Equipment			
d. Supplies			
e. Travel			
f. Other			
3. Indirect Costs	29,371		
4. Other Applicable Costs	2,994		
5. Subtotal--Estimated Costs	79,948		
6. Less Proposed Cost Sharing (if any)			
7. Carryover Funds (if any) a. Anticipated amount _____ b. Amount used to reduce budget			
8. Total Estimated Costs	79,948		XXXXXXX
APPROVED BUDGET	XXXXXXX	XXXXXXX	

Instructions

1. Provide a separate budget summary sheet for each year of the proposed research.

2. Grantee estimated costs should be entered in Column A. Columns B and C are for NASA use only. Column C represents the approved grant budget.

3. Provide in attachments to the budget summary the detailed computations of estimates in each cost category, along with any narrative explanation required to fully explain proposed costs.

------------------------- ADDITIONAL INSTRUCTIONS ON REVERSE -------------------------

07/19/1995   Southwest Research Institute   Attachment A
                    Proposal Number: 15-13046-D   6 pages
                    RFP/RFQ Number: NRA OSSA-92-3

Client - NASA HEADQUARTERS

PROPOSAL INDEX
==
Title   Page
==

Client - NASA HEADQUARTERS
Title - ENERGETICS & DYNAMICS OF JUPITER UPPER ATMOSPHERE - 3RD YEAR

                    C O S T   S U M M A R Y
==

DIRECT LABOR COSTS (specifics attached)
  Labor - Standard   16,909
  Burden - Standard   (43.70%)   7,389
        Total Direct Labor $24,298

OVERHEAD
  Standard   (118.00%)   28,672
        Total Overhead $28,672

COST OF FACILITIES CAPITAL (CFC)
  Standard   (12.320%)   2,994
        Total Cost of Facilities Capital $2,994

     Subtotal Labor Costs $55,964

OTHER COSTS (specifics attached)
  Subcontracting   23,285
  Material Handling Burden (3.000%)   699
        Subtotal Other Costs $23,984

     Total Estimated Costs $79,948

Title - ENERGETICS & DYNAMICS OF JUPITER UPPER ATMOSPHERE - 3RD YEAR

ATTACHMENT TO COST SUMMARY
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* * * * * * * * * * * * * L A B O R * * * * * * * * * * * * * * * * * *

LABOR - STANDARD

	Est Man Hours	Hourly Rate	Amount
PROFESSIONAL LEVEL 4	280.0	60.39	16,909

	Amount	
Total Labor	$16,909	
Burden to Cover Fringe Benefits: (43.70%)	$7,389	
Total Direct Labor Cost (TDLC)		$24,298
Overhead (118.00%) of TDLC		$28,672
Cost of Facilities Capital (12.320%) of TDLC		$2,994

* * * * * * * * * * * * S U B C O N T R A C T I N G * * * * * * * * * * * *

Company	Service	Amount
DR. S. BOUGHER, THE UNIVERSITY OF ARIZONA		23,285
Total Subcontracting		$23,285

Title - ENERGETICS & DYNAMICS OF JUPITER UPPER ATMOSPHERE - 3RD YEAR
Performance Period - 08/01/1995 Thru 07/31/1996

GOVERNMENT ESCALATION RATES

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*** Professional	& Technical ***			***	Clerical & Lab Assistant ***		
Fiscal Year	Escalation Rate	No. of Months	Adj. by Year	Fiscal Year	Escalation Rate	No. of Months	Adj. by Year
1995	1.00000	2.0	2.00000	1995	1.00000	2.0	2.00000
1996	1.03100	10.0	10.31000	1996	1.03700	10.0	10.37000
Totals		12.0	12.31000			12.0	12.37000
Adjustments			1.02583				1.03083

Proposal Number 15-13046-D
RFP/RFQ Number   NRA OSSA-92-3

Title - ENERGETICS & DYNAMICS OF JUPITER UPPER ATMOSPHERE - 3RD YEAR
Performance Period - 08/01/1995 thru 07/31/1996

L A B O R   R A T E   W O R K S H E E T

===

** REGULAR HOURLY RATES **

Div	Prof. Level	Date of Last Increase	Hourly Rate	Adjustment Rate	Adjusted Hourly Rate	Labor Percent	Labor Amount	Weighted Average Rate
15	PL4	06/23/1995	58.87	1.02583	60.39			60.39
15	PL3	06/23/1995	38.70	1.02583	39.70			39.70
15	PL2	06/23/1995	28.09	1.02583	28.82			28.82
15	PL1	06/23/1995	20.41	1.02583	20.94			20.94
15	ST	06/23/1995	15.30	1.02583	15.70			15.70
15	T	06/23/1995	9.40	1.02583	9.64			9.64
15	C	06/23/1995	11.27	1.03083	11.62			11.62
15	LA	06/23/1995	5.00	1.03083	5.15			5.15
15	MSA	05/02/1995	35.69	1.02583	36.61			36.61
15	MSB	05/02/1995	28.95	1.02583	29.70			29.70
15	MSC	05/02/1995	13.88	1.02583	14.24			14.24
15	MSH	05/02/1995	18.30	1.02583	18.77			18.77
15	MSN	05/02/1995	31.33	1.02583	32.14			32.14
15	MSW	05/02/1995	28.43	1.02583	29.16			29.16
15	QA3	03/14/1995	93.24	1.02583	95.65			95.65
15	QA2	03/14/1995	76.24	1.02583	78.21			78.21
15	QA1	03/14/1995	59.67	1.02583	61.21			61.21
15	QAT	03/14/1995	40.10	1.02583	41.14			41.14
15	QAD	03/14/1995	31.43	1.03083	32.40			32.40

** OVERTIME RATES **

Prof. Level	Regular Rate	Premium Rate	Fee	Total
PL4	60.39			60.39
PL3	39.70			39.70
PL2	28.82			28.82
PL1	20.94			20.94
ST	15.70	7.85		23.55
T	9.64	4.82		14.46
C	11.62	5.81		17.43

(Continued)

Southwest Research Institute
Proposal Number 15-13046-D
RFP/RFQ Number   NRA OSSA-92-3

** OVERTIME RATES **

Prof. Level	Regular Rate	Premium Rate	Fee	Total
LA	5.15	2.58		7.73
MSA	36.61	9.35		45.96
MSB	29.70	7.58		37.28
MSC	14.24	3.63		17.87
MSH	18.77	4.79		23.56
MSN	32.14	7.34		39.48
MSW	29.16	7.44		36.60
QA3	95.65			95.65
QA2	78.21			78.21
QA1	61.21			61.21
QAT	41.14	7.27		48.41
QAD	32.40	5.73		38.13

DIRECT RATES
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1. DIRECT LABOR RATES: Weighted average rates for each labor
    category are estimated based on utilization with appropriate
    escalation as follows:

Fiscal Year	Professional and Technical	Clerical and Laboratory Assistant
1995	0.000%	0.000%
1996	3.100%	3.700%

INDIRECT RATES
===============

1. BURDEN:

    Applied at the rate of 43.70% of the total Institute
    salaries and wages base of allocation.

2. OVERHEAD:

    Applied at the rate of 118.00% of the total Institute
    Labor cost base of allocation.

3. COST OF FACILITIES CAPITAL:

    Applied at the rate of 12.320% of the total direct Institute
    labor cost base of allocation.

4. MATERIAL HANDLING BURDEN:

    Applied at the rate of   3.000% of the total cost of materials
    and supplies and subcontracting.

CONTRACT FACILITIES CAPITAL COST OF MONEY

Form Approved
OMB No. 0704-0267
Expires Oct. 31, 1989

1. CONTRACTOR NAME	2. CONTRACTOR ADDRESS
SOUTHWEST RESEARCH INSTITUTE	P.O. DRAWER 28510
3. BUISNESS UNIT	6220 CULEBRA ROAD
SAN ANTONIO	SAN ANTONIO, TEXAS 78284
4. RFP / CONTRACT PIIN NUMBER	5. PERFORMANCE PERIOD
NRA OSSA-92-3	08/01/95 THRU 07/31/96

6. DISTRIBUTION OF FACILITIES CAPITAL COST OF MONEY

		FACILITIES CAPITAL COST OF MONEY	
POOL	ALLOCATION BASE	FACTOR	AMOUNT
DIRECT LABOR	$24,298	0.10601	$2,576
G & A	$24,298	0.01719	$418
TOTAL		0.12320	$2,994
TREASURY RATE			8.125%
FACILITIES CAPITAL EMPLOYED (TOTAL DIVIDED BY TREASURY RATE)			$36,843

7. DISTRIBUTION OF FACILITIES CAPITAL EMPLOYED

	PERCENTAGE	AMOUNT
LAND	4%	$1,474
BUILDINGS	68%	$25,053
EQUIPMENT	28%	$10,316
FACILITIES CAPITAL EMPLOYED	100%	$36,843

DD Form 1861, AUG 87   *Supersedes all previous editions of DD Forms 1861-1 and 1861-2, which are obsolete.*

FACILITIES CAPITAL COST OF MONEY FACTORS COMPUTATION   29-Mar-95

SOUTHWEST RESEARCH INSTITUTE
PO DRAWER 28510
SAN ANTONIO, TEXAS 78228

BUSINESS UNIT: N/A

COST ACCOUNTING PERIOD:
FYE 09/29/95 - PROJECTED

	1. APPLICABLE C.O.M. 8.125%	2. ACCUMULATION & DIRECT DIST. OF N.B.V.	3. ALLOCATION OF UNDISTRIBUTED BASIS OF ALLOCATION	4. TOTAL NET BOOK VALUE COLUMNS 2 + 3	5. C.O.M. FOR THE COST ACCTNG. PD. COLUMNS 1 x 4	6. ALLOCATION BASE FOR THE PERIOD IN UNIT(S) OF MEASURE	7. FACILITIES CAPITAL C.O.M. FACTORS COLUMNS 5 / 6
BUSINESS UNIT FACILITIES CAPITAL							
RECORDED		95,382,069		95,382,069			
LEASED PROPERTY		0					
CORPORATE GROUP		0					
TOTAL		95,382,069					
DISTRIBUTED		79,978,468					
UNDISTRIBUTED		15,403,601					
OVERHEAD POOLS							
OFFSITE LAB STAFF		0	0	0	0	8,051,453	0.00000
BF&L LAB STAFF		166,600	0	166,600	13,536	1,242,248	0.01090
CNWRA STAFF		3,667,505	0	3,667,505	297,985	5,135,761	0.05802
REGULAR STAFF		76,144,363	0	76,144,363	6,186,729	58,359,965	0.10601
G&A EXPENSE POOLS							
G&A EXPENSE		0	15,403,601	15,403,601	1,251,543	72,789,427	0.01719
TOTAL		79,978,468	15,403,601	95,382,069	7,749,793		

Exhibit 2

CERTIFICATION REGARDING
DEBARMENT, SUSPENSION, AND OTHER RESPONSIBILITY MATTERS
PRIMARY COVERED TRANSACTIONS

This certification is required by the regulations implementing Executive Order 12549, Debarment and Suspension, 34 CFR Part 85, Section 85.510, Participant's responsibilities. The regulations were published as Part VII of the May 26, 1988 Federal Register (pages 19160–19211). Copies of the regulations may be obtained by contacting the U. S. Department of Education, Grants and Contracts Service, 400 Maryland Avenue, S. W. (Room 3633 GSA Regional Office Building No. 3), Washington, D. C. 20202-4725, telephone (202) 732-2505.

(1) The prospective primary participant certifies to the best of its knowledge and belief, that it and its principals:

    (a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;

    (b) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

    (c) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (1)(b) of this certification; and

    (d) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default.

(2) Where the prospective primary participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

Southwest Research Institute	*Dr. J. Hunter Waite, Jr.*
Institution	Principal Investigator

Robert E. Chatten, Director, Contracts

Name and Title of Authorized Representative

Signature	7/20/95
	Date

C-6

CERTIFICATION REGARDING DRUG-FREE WORKPLACE REQUIREMENTS
GRANTEES OTHER THAN INDIVIDUALS

This certification is required by the regulations implementing the Drug-Free Workplace Act of 1988, 34 CFR Part 85, Subpart F. The regulations, published in the January 31, 1989 Federal Register, require certification by grantees, prior to award, that they will maintain a drug-free workplace. The certification set out below is a material representation of fact upon which reliance will be placed when the agency determines to award the grant. False certification or violation of the certification shall be grounds for suspension of payments, suspension or termination of grants, or government wide suspension or debarment (see 34 CFR Part 85, Sections 85.615 and 85.620).

The grantee certifies that it will provide a drug-free workplace by:

(a) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition;

(b) Establishing a drug-free awareness program to inform employees about—
   (1) The dangers of drug abuse in the workplace;
   (2) The grantee's policy of maintaining a drug-free workplace;
   (3) Any available drug counseling, rehabilitation, and employee assistance programs; and
   (4) The penalties that may be imposed upon employees for drug abuse violations occurring in the workplace;

(c) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (a);

(d) Notifying the employee in the statement required by paragraph (a) that, as a condition of employment under the grant, the employee will—
   (1) Abide by the terms of the statement; and
   (2) Notify the employer of any criminal drug statute conviction for a violation occurring in the workplace no later than five days after such conviction;

(e) Notifying the agency within ten days after receiving notice under subparagraph (d)(2) from an employee or otherwise receiving actual notice of such conviction;

(f) Taking one of the following actions, within 30 days of receiving notice under subparagraph (d)(2), with respect to any employee who is so convicted—
   (1) Taking appropriate personnel action against such an employee, up to and including termination; or
   (2) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State, or local health, law enforcement, or other appropriate agency;

(g) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraphs (a), (b), (c), (d), (e) and (f).

Southwest Research Institute	*Dr. J. Hunter Waite, Jr.*
Institution	Principal Investigator

Robert E. Chatten, Director, Contracts

Name and Title of Authorized Representative

	7/20/95
Signature	Date

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CERTIFICATION REGARDING LOBBYING

As required by S1352 Title 31 of the U.S. Code for persons entering into a grant or cooperative agreement over $100,000, the applicant certifies that:

(a) No Federal appropriated funds have been paid or will be paid by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, in connection with making of any Federal grant, the entering into of any cooperative, and the extension, continuation, renewal, amendment, or modification of any Federal grant or cooperative agreement;

(b) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting an officer or employee of any agency, Member of Congress, an or an employee of a Member of Congress in connection with this Federal grant or cooperative agreement, the undersigned shall complete Standard Form -LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(c) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subgrants, contracts under grants and cooperative agreements, and subcontracts), and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by S1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less that $10,000 and not more than $100,000 for each such failure.

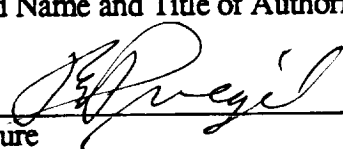|	
Southwest Research Institute	*NRA OSSA-92-3*
Organization Name	AO or NRA Number and Name

Robert E. Chatten, Director, Contracts

Printed Name and Title of Authorized Representative

Signature	7/22/95
	Date

Dr. J. Hunter Waite, Jr.	*Energetics & Dynamics of Jupiter Upper Atmosphere - 3rd Year*
Printed Principal Investigator Name	Proposal Title

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